



Standard Specification for Emergency Conditions, Occupant Safety and Accommodations¹

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1. Scope

1.1 This specification addresses emergency conditions, occupant safety and accommodations for occupants and cargo.

1.2 The applicant for a design approval must seek the individual guidance of their respective CAA body concerning the use of this standard as part of a certification plan. For information on which CAA regulatory bodies have accepted this standard (in whole or in part) as a means of compliance to their airworthiness regulations (Hereinafter referred to as “the Rules”), refer to ASTM F44 webpage (www.ASTM.org/COMITTEE/F44.htm) which includes CAA website links.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*²

F3060 Terminology for Aircraft

2.2 *U.S. Code of Federal Regulations:*³

14 CFR Part 23 Airworthiness Standards: Normal, Utility, Aerobatic and Commuter Category Airplanes (Amendment 62)

49 CFR Part 572 Anthropomorphic Test Devices (Subpart B)

¹ This specification is under the jurisdiction of ASTM Committee F44 on General Aviation Aircraft and is the direct responsibility of Subcommittee F44.30 on Structures.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ Available from the U.S. Government Printing Office at www.ecfr.gov.

2.3 *European Aviation Safety Agency Regulations:*⁴

CS-23 Certification Specifications for Normal, Utility, Aerobatic, and Commuter Category Aeroplanes (Amendment 3)

CS-VLA Certifications Specifications for Very Light Aeroplanes (Amendment 1)

2.4 *Other Standard:*

PH1.25 Standard Specification for Safety Photographic Film

3. Terminology

3.1 See Terminology **F3060** for definitions of terms used in this standard.

3.2 *Abbreviations:*

3.2.1 g_p —peak deceleration for seat/restraint system test

3.2.2 *HIC*—head injury criteria

3.2.3 t_r —rise time to the peak deceleration, g_p

4. Emergency Landing Conditions

4.1 *General:*

4.1.1 The airplane, although it may be damaged in emergency landing conditions, must be designed as prescribed in this section to protect each occupant under those conditions.

4.1.2 The structure must be designed to give each occupant every reasonable chance of escaping serious injury when:

4.1.2.1 Proper use is made of the seats, safety belts, and shoulder harnesses provided for in the design.

4.1.2.2 The occupant experiences the static inertia loads corresponding to the following ultimate load factors:

(1) Upward, 3.0 g , or 4.5 g for airplanes approved for aerobatics;

(2) Forward, 9.0 g ;

(3) Sideward, 1.5 g ; and

(4) Downward, 6.0 g when certification to the emergency exit provisions of **5.6.4.1(2)** is requested.

4.1.2.3 The items of mass within the cabin, that could injure an occupant, experience the static inertia loads corresponding to the following ultimate load factors:

(1) For Level 1 aircraft with a V_{SO} not more than 83 km/h [45 kts]:

⁴ Available from the European Aviation Safety Agency at www.easa.europa.eu.

- (a) Upward, 3.0 g;
- (b) Forward, 9.0 g; and
- (c) Sideward, 1.5 g.
- (2) For all other aircraft:
 - (a) Upward, 3.0 g;
 - (b) Forward, 18.0 g; and
 - (c) Sideward, 4.5 g.

4.1.3 Each airplane with retractable landing gear must be designed to protect each occupant in a landing:

- 4.1.3.1 With the wheels retracted;
- 4.1.3.2 With moderate descent velocity; and
- 4.1.3.3 Assuming, in the absence of a more rational analysis:

- (1) A downward ultimate inertia force of 3 g; and
- (2) A coefficient of friction of 0.5 at the ground.

4.1.4 Unless it is established that a turnover is unlikely during an emergency landing, the structure must be designed to protect the occupants in a complete turnover. For determining the loads to be applied to the inverted airplane after a turnover, in the absence of a more rational analysis, an upward ultimate inertia load factor of 3.0 g and a coefficient of friction with the ground of 0.5 must be used.

4.1.4.1 For Level 1 aircraft, it must be assumed that turnover is likely.

4.1.4.2 For Level 2 through 4 aircraft, the likelihood of a turnover may be shown by an analysis assuming the following conditions:

- (1) The most adverse combination of weight and center of gravity position;
- (2) Longitudinal load factor of 9.0 g;
- (3) Vertical load factor of 1.0 g; and
- (4) For airplanes with tricycle landing gear, the nose wheel strut failed with the nose contacting the ground.

4.1.5 Except as provided in 5.5.1.4, the supporting structure must be designed to restrain, under loads up to those specified in 4.1.2.3, each item of mass that could injure an occupant if it came loose in a minor crash landing.

4.1.6 Engine mount and supporting structure must withstand 15 g forward for engines installed behind and above the seating compartment.

4.1.7 For engines mounted inside the fuselage, aft of the cabin, it must be shown by test or analysis that the engine and attached accessories, and the engine mounting structure:

4.1.7.1 Can withstand a forward acting static ultimate inertia load factor of 18.0 g plus the maximum takeoff engine thrust; or

4.1.7.2 The airplane structure is designed to preclude the engine and its attached accessories from entering or protruding into the cabin should the engine mounts fail.

4.2 Dynamic Conditions:

4.2.1 Each seat/restraint system must be designed to protect each occupant during an emergency landing when:

4.2.1.1 Proper use is made of seats, safety belts, and shoulder harnesses provided for in the design; and

4.2.1.2 The occupant is exposed to the loads resulting from the conditions prescribed in this section.

4.2.2 Except for those seat/restraint systems that are required to meet 4.2.4 or 4.2.5, each seat/restraint system for

crew or passenger occupancy during takeoff and landing, must successfully complete dynamic tests, or be demonstrated by rational analysis supported by dynamic tests, in accordance with each of the following conditions. These tests must be conducted with an occupant simulated by an anthropomorphic test device (ATD) defined by 49 CFR part 572, subpart B, or an approved equivalent, with a nominal weight of 77 kg [170 lb] and seated in the normal upright position.

4.2.2.1 For the first test, the change in velocity must not be less than 9.4 m/s [31 ft/s]. The seat/restraint system must be oriented in its nominal position with respect to the airplane and with the horizontal plane of the airplane pitched up 60°, with no yaw, relative to the impact vector. For seat/restraint systems to be installed in the first row of the airplane, peak deceleration must occur in not more than 0.05 s after impact and must reach a minimum of 19 g. For all other seat/restraint systems, peak deceleration must occur in not more than 0.06 s after impact and must reach a minimum of 15 g.

4.2.2.2 For the second test, the change in velocity must not be less than 12.8 m/s [42 ft/s]. The seat/restraint system must be oriented in its nominal position with respect to the airplane and with the vertical plane of the airplane yawed 10°, with no pitch, relative to the impact vector in a direction that results in the greatest load on the shoulder harness. For seat/restraint systems to be installed in the first row of the airplane, peak deceleration must occur in not more than 0.05 s after impact and must reach a minimum of 26 g. For all other seat/restraint systems, peak deceleration must occur in not more than 0.06 s after impact and must reach a minimum of 21 g.

4.2.2.3 To account for floor warpage, the floor rails or attachment devices used to attach the seat/restraint system to the airframe structure must be preloaded to misalign with respect to each other by at least 10° vertically (that is, pitch out of parallel) and one of the rails or attachment devices must be preloaded to misalign by 10° in roll prior to conducting the test defined by 4.2.2.2.

4.2.3 Compliance with the following requirements must be shown during the dynamic tests conducted in accordance with 4.2.2:

4.2.3.1 The seat/restraint system must restrain the ATD although seat/restraint system components may experience deformation, elongation, displacement, or crushing intended as part of the design.

4.2.3.2 The attachment between the seat/restraint system and the test fixture must remain intact, although the seat structure may have deformed.

4.2.3.3 Each shoulder harness strap must remain on the ATD's shoulder during the impact.

4.2.3.4 The safety belt must remain on the ATD's pelvis during the impact.

4.2.3.5 The results of the dynamic tests must show that the occupant is protected from serious head injury.

(1) When contact with adjacent seats, structure, or other items in the cabin can occur, protection must be provided so that the head impact does not exceed a head injury criteria (HIC) of 1000.

(2) The value of HIC is defined as:



$$HIC = \left\{ (t_2 - t_1) \left[\frac{1}{(t_2 - t_1)} \int_{t_1}^{t_2} a(t) dt \right]^{2.5} \right\}_{Max} \quad (1)$$

where:

- t_1 = the initial integration time, expressed in seconds;
- t_2 = the final integration time, expressed in seconds; and
- $a(t)$ = the total acceleration vs. time curve for the head strike expressed as a multiple of g (units of gravity).

(3) Compliance with the HIC limit must be demonstrated by measuring the head impact during dynamic testing as prescribed in 4.2.2.1 and 4.2.2.2 or by a separate showing of compliance with the head injury criteria using test or analysis procedures.

4.2.3.6 Loads in individual shoulder harness straps must not exceed 7784 N [1750 lb_f]. If dual straps are used for retaining the upper torso, the total strap loads must not exceed 8896 N [2000 lb_f].

4.2.3.7 The compression load measured between the pelvis and the lumbar spine of the ATD must not exceed 6672 N [1500 lb_f].

4.2.4 For all single-engine airplanes with a V_{S0} of more than 113 km/h [61 kts] at maximum weight, and those multiengine airplanes of 2722 kg [6000 lb] or less maximum weight with a V_{S0} of more than 113 km/h [61 kts] at maximum weight that do not comply with §23.67(a)(1) of 14 CFR Part 23.

4.2.4.1 The ultimate load factors of 4.1.2 must be increased by multiplying the load factors by the square of the ratio of the increased stall speed to 113 km/h [61 kts]. The increased ultimate load factors need not exceed the values reached at a V_{S0} of 146 km/h [79 kts]. The upward ultimate load factor for aircraft approved for aerobatics need not exceed 5.0 g .

4.2.4.2 The seat/restraint system test required by 4.2.2.1 of this section must be conducted in accordance with the following criteria:

(1) The change in velocity must not be less than 9.4 m/s [31 ft/s].

(2) The peak deceleration (g_p) of 19 g and 15 g must be increased and multiplied by the square of the ratio of the increased stall speed to $V_{normalize} = 113$ km/h [61 kts]:

$$g_p = 19.0 (V_{S0} / V_{normalize})^2 \quad \text{or} \quad g_p = 15.0 (V_{S0} / V_{normalize})^2 \quad (2)$$

(a) The peak deceleration need not exceed the value reached at a V_{S0} of 146 km/h [79 kts].

(3) The peak deceleration must occur in not more than time (t_r), which must be computed as follows:

$$t_r = \frac{31}{32.2(g_p)} = \frac{0.96}{g_p} \quad (3)$$

where:

g_p = the peak deceleration calculated in accordance with 4.2.4.2(2); and

t_r = the rise time (in seconds) to the peak deceleration.

4.2.5 For Level 1 aircraft with a maximum takeoff weight of not more than 750 kg [1653 lb] and a stalling speed in the landing configuration of not more than 83 km/h [45 kts], the requirements of 4.2.2 and 4.2.3 are not required if the following conditions are met:

4.2.5.1 Each seat and its supporting structure must be designed for occupants weighing at least 86 kg [190 lb], and

for the maximum load factors corresponding to the specified flight and ground load conditions, including the emergency landing conditions prescribed in 4.1.2.2.

4.2.5.2 Each occupant must be protected from serious head injury by a safety belt and shoulder harness when the occupant experiences the inertia forces prescribed in 4.1.2.2. (For reference, see Appendix X1.)

4.2.6 An alternate approach that achieves an equivalent, or greater, level of occupant protection to that required by this section may be used if substantiated on a rational basis.

5. Occupant and Cargo Accommodations

5.1 Seats, Berths, Litters, Safety Belts, and Shoulder Harnesses:

5.1.1 There must be a seat or berth for each occupant that meets the following:

5.1.1.1 Each seat/restraint system and the supporting structure must be designed to support occupants weighing at least 98 kg [215 lb] when subjected to the maximum load factors corresponding to the specified flight and ground load conditions, as defined in the approved operating envelope of the airplane. In addition, these loads must be multiplied by a factor of 1.33 in determining the strength of all fittings and the attachment of:

(1) Each seat to the structure; and

(2) Each safety belt and shoulder harness to the seat or structure.

5.1.1.2 Each forward-facing or aft-facing seat/restraint system in Level 1 through 3 airplanes must consist of a seat, a safety belt, and a shoulder harness, with a metal-to-metal latching device, that are designed to provide the occupant protection provisions required in 4.2. Other seat orientations must provide the same level of occupant protection as a forward-facing or aft-facing seat with a safety belt and a shoulder harness, and must provide the protection provisions of 4.2.

5.1.1.3 For Level 4 airplanes, each seat and the supporting structure must be designed for occupants weighing at least 77 kg [170 lb] when subjected to the inertia loads resulting from the ultimate static load factors prescribed in 4.1.2.2. Each occupant must be protected from serious head injury when subjected to the inertia loads resulting from these load factors by a safety belt and shoulder harness, with a metal-to-metal latching device, for the front seats and a safety belt, or a safety belt and shoulder harness, with a metal-to-metal latching device, for each seat other than the front seats.

5.1.1.4 Each restraint system must have a single-point release for occupant evacuation.

5.1.1.5 The restraint system for each crewmember must allow the crewmember, when seated with the safety belt and shoulder harness fastened, to perform all functions necessary for flight operations.

5.1.1.6 Each pilot seat must be designed for the reactions resulting from the application of pilot forces to the primary flight controls.

5.1.1.7 There must be a means to secure each safety belt and shoulder harness, when not in use, to prevent interference with the operation of the airplane and with rapid occupant egress in an emergency.



5.1.1.8 Unless otherwise placarded, each seat in an airplane approved for bank angles greater than 60°, spins or aerobatics must be designed to accommodate an occupant wearing a parachute.

5.1.1.9 The cabin area surrounding each seat, including the structure, interior walls, instrument panel, control wheel, pedals, and seats within striking distance of the occupant's head or torso (with the restraint system fastened) must be free of potentially injurious objects, sharp edges, protuberances, and hard surfaces. If energy absorbing designs or devices are used to meet this requirement, they must protect the occupant from serious injury when the occupant is subjected to the inertia loads resulting from the ultimate static load factors prescribed in 4.1.2.2, or they must comply with the occupant protection provisions of 4.2, as required in 5.1.1.2 and 5.1.1.3.

5.1.1.10 Each seat track must be fitted with stops to prevent the seat from sliding off the track.

5.1.1.11 Each seat/restraint system may use design features, such as crushing or separation of certain components, to reduce occupant loads when showing compliance with the requirements of 4.2; otherwise, the system must remain intact.

5.1.1.12 For the purposes of this section, a front seat is a seat located at a flight crewmember station or any seat located alongside such a seat.

5.1.1.13 Each berth, or provisions for a litter, installed parallel to the longitudinal axis of the airplane, must be designed so that the forward part has a padded end-board, canvas diaphragm, or equivalent means that can withstand the load reactions from a 98 kg [215 lb] occupant when subjected to the inertia loads resulting from the ultimate static load factors of 4.1.2.2. In addition:

(1) Each berth or litter must have an occupant restraint system and may not have corners or other parts likely to cause serious injury to a person occupying it during emergency landing conditions; and

(2) Occupant restraint system attachments for the berth or litter must withstand the inertia loads resulting from the ultimate static load factors of 4.1.2.2.

5.1.1.14 Proof of compliance with the static strength requirements of this section for seats and berths approved as part of the type design and for seat and berth installations may be shown by:

(1) Structural analysis, if the structure conforms to conventional airplane types for which existing methods of analysis are known to be reliable;

(2) A combination of structural analysis and static load tests to limit load; or

(3) Static load tests to ultimate loads.

5.2 Doors:

5.2.1 Each closed cabin with passenger accommodations must have at least one adequate and easily accessible external door.

5.2.2 Passenger doors must not be located with respect to any propeller disk or any other potential hazard so as to endanger persons using the door.

5.2.3 In addition, for Level 4 airplanes, the following requirements apply:

5.2.3.1 Each passenger entry door must qualify as a floor level emergency exit. This exit must have a rectangular opening of not less than 0.61 m [2 ft] wide by 1.22 m [4 ft] high, with corner radii not greater than one-third the width of the exit.

5.2.3.2 If an integral stair is installed at a passenger entry door, the stair must be designed so that, when subjected to the inertia loads resulting from the ultimate static load factors in 4.1.2.2 and following the collapse of one or more legs of the landing gear, it will not reduce the effectiveness of emergency egress through the passenger entry door.

5.2.4 If lavatory doors are installed, they must be designed to preclude an occupant from becoming trapped inside the lavatory. If a locking mechanism is installed, it must be capable of being unlocked from outside of the lavatory.

5.3 Baggage and Cargo Compartments:

5.3.1 Each baggage and cargo compartment must:

5.3.1.1 Be designed for its placarded maximum weight of contents and for the critical load distributions at the appropriate maximum load factors corresponding to the specified flight and ground load conditions.

5.3.1.2 Have means to prevent the contents of any compartment from becoming a hazard by shifting, and to protect any controls, wiring, lines, equipment or accessories whose damage or failure would affect safe operations.

5.3.1.3 Have a means to protect occupants from injury by the contents of any compartment, located aft of the occupants and separated by structure, when the ultimate forward inertial load factor is 9 g and assuming the maximum allowed baggage or cargo weight for the compartment.

5.3.2 Designs that provide for baggage or cargo to be carried in the same compartment as passengers must have a means to protect the occupants from injury when the baggage or cargo is subjected to the inertial loads resulting from the ultimate static load factors of 4.1.2.3, assuming the maximum allowed baggage or cargo weight for the compartment.

5.3.2.1 For Level 1 aircraft with a V_{SO} not more than 83 km/h [45 kts], if there is no structure between baggage and occupant compartments the baggage items located behind the occupants and those which might become a hazard in a crash must be secured for 1.33×9 g.

5.4 Emergency Evacuation:

5.4.1 For Level 4 airplanes, an evacuation demonstration must be conducted utilizing the maximum number of occupants for which certification is desired. The demonstration must be conducted under simulated night conditions using only the emergency exits on the most critical side of the airplane. The participants must be representative of average passengers with no prior practice or rehearsal for the demonstration. Evacuation must be completed within 90 s.

5.4.2 In addition, when certification to the emergency exit provisions of 5.6.4.1(2) is requested, only the emergency lighting system required by 5.8 may be used to provide cabin interior illumination during the evacuation demonstration required in 5.4.1.

5.5 Flightcrew Emergency Exits: